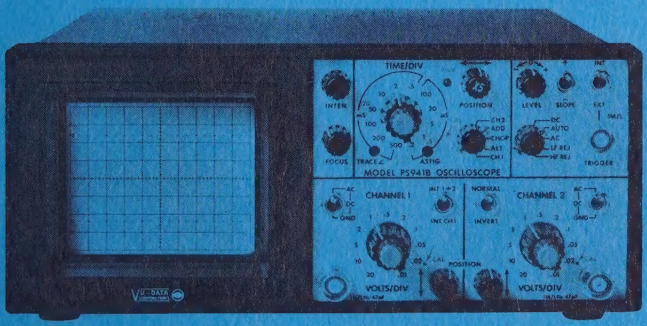
OPERATOR'S MANUAL

SERIES PS940B

MINI-PORTABLE OSCILLOSCOPES

April, 1978



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PREFACE

This Operator's Manual is comprised of "Section III - Operation" from the Technical Manual for the Series PS940 Mini-scope.

It is provided with each unit as a convenient reference for instrument operation where the complete technical manual may not be readily available or not required.

Each instrument operator is urged to review the contents of this manual to ensure a complete understanding and maximum usage of the full capabilities of each and every operating control.

SECTION III

OPERATION

3-1. OPERATING INSTRUCTIONS

3-2. FRONT PANEL CONTROL FUNCTIONS AND CONNECTIONS

The Series PS940 front panel controls are divided up into five sections for ease of identification and operation. These sections are as follows: Channel 1 vertical input and controls, Channel 2 vertical input and controls, trigger input and controls, sweep controls and CRT controls. Paragraphs 3-3 through 3-7 describe the Model PS941 front panel controls and connectors. Paragraph 3-8 describes the different controls used for the Model PS943 that are in addition to the ones used on the PS941.

3-3. Channel 1 Vertical Section

a) BNC CONNECTOR — Signal input connector for CHANNEL 1. Impedance is 1 megohm paralleled by approximately 47 pf.

b) POSITION — Positions the CHANNEL 1 trace vertically on the CRT, and also controls vertical trace position in the ADD mode.

c) INPUT COUPLING (AC/DC/GND) — Three position switch controls the signal coupling to the vertical attenuator, either in a direct (DC) or capacitive (AC) mode. The third position (GND), grounds the vertical attenuator input without grounding the input signal.

d) VERTICAL SENSITIVITY (VOLTS/DIV) — Eleven position switch which selects calibrated vertical deflection factors from 10mV per division to 20 volts per division in a 1-2-5 sequence.

e) VERNIER GAIN — Red knob in center of VOLTS/DIV knob provides a variable deflection factor when moved out of the CAL (or detented) position. It provides for overlapping vertical deflection factors and extends the 20 volt/division range to approximately 50 volts per division.

f) TRIGGER SELECT (INT 1+2/INT CH 1) — Two position switch which selects the source of internal trigger signals. INT CH 1 allows trigger signals from CH 1 only, while INT 1+2 selects a trigger signal which is the summation of signals in both Ch 1 and Ch 2 vertical amplifiers.

3-4. Channel 2 Vertical Section

a) BNC CONNECTOR — Signal input connector for CHANNEL 2. Impedance is 1 megohm paralleled by approximately 47 pf.

b) POSITION — Positions the CHANNEL 2 trace vertically on the CRT.

c) INPUT COUPLING (AC/DC/GND) — Three position switch controls the signal coupling to the vertical attenuator, either in a direct (DC), or capacitive (AC) mode. The third position (GND), grounds the vertical attenuator input without grounding the input signal.

d) VERTICAL SENSITIVITY (VOLTS/DIV) — Eleven position switch which selects calibrated vertical deflection factors from 10mV per division to 20 volts per division in a 1-2-5 sequence.

e) VERNIER GAIN — Red knob in center of VOLTS/DIV knob provides a variable deflection factor when moved out of the CAL (or detented) position. It provides for overlapping vertical deflection factors and extends the 20 volt/division range to approximately 50 volts per division.

f) CH 2 POLARITY (NORMAL/INVERT) — Two position switch which selects zero degrees (NORMAL) or 180^{o} phase shift (INVERT) of the CHANNEL 2 input signal.

3-5. Trigger Section

a) BNC CONNECTOR — External trigger signal input connector. Impedance is one megohm.

b) SOURCE (INT/EXT) — Two position switch which selects a trigger signal from either the internal vertical signal or the signal at the external trigger BNC connector. In the INT position, the trigger signal is dependent upon the setting of INT 1+2/INT CH 1 switch.

c) SLOPE (+/–) — Two position switch allows control of the slope of the trigger signal.

d) LEVEL — Controls the point on the trigger signal wave form at which the horizontal sweep will start. This control is inoperative when in the automatic trigger mode, since in AUTO, the sweep starts at the zero axis crossing.

e) MODE (DC/AUTO/AC/LF REJ/HF REJ) — Five position trigger mode and coupling switch. In DC, the trigger signal is direct coupled to the trigger generator. In the other four positions, the trigger signal is AC coupled. The AUTO mode causes the sweep to free run in the absence of a trigger signal to provide a reference baseline. In AC, the trigger

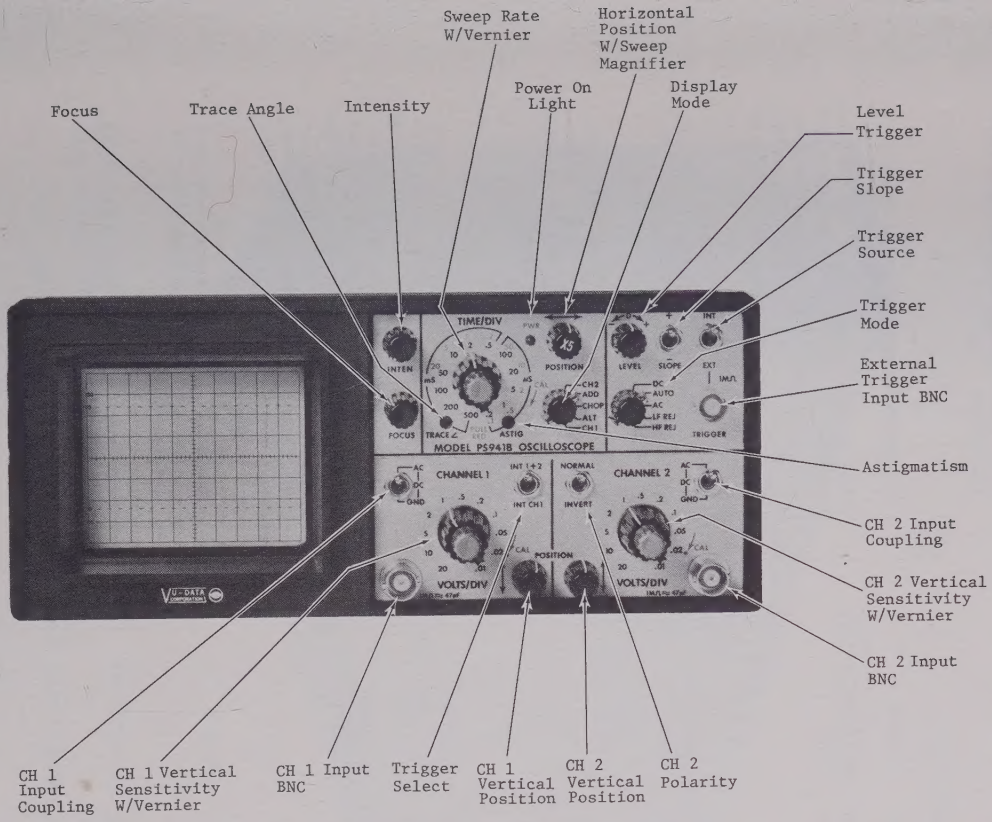

Figure 3-1. Series PS940 Operating Controls

amplitude requirements increase below 40 Hz. The amplitude requirements increase below 50 Hz in the LF REJ position and above 50 KHz in the HF REJ position.

3-6. Sweep Section

a) POSITION	Controls the horizontal position of the trace.
b) SWEEP MAGNIFIER (X5)	Push-pull switch actuated by pulling the horizontal position knob out. In the extended position (out) the sweep rate is magnified five (5) times faster than indicated by sweep rate (TIME/DIV) switch. In the non-extended (in) position the sweep is at the basic sweep rate (X1).
c) SWEEP RATE (TIME/DIV)	Twelve position, plus push-pull selector, provides 21 calibrated sweep ranges from 100 nanosec/div to .5 sec/div.
d) VERNIER	Center red knob of the TIME/DIV control slows down the sweep speed as the control is rotated counterclockwise. When the knob is clockwise in the CAL position, the sweep rate is as indicated by the TIME/DIV knob. The sweep rates indicated in red are selected by pulling out on the Vernier knob.
e) DISPLAY MODE (CH 2/ADD/CHOP/ ALT/CH 1)	Five position switch controls the mode of operation. CH 1 position selects Ch 1 only. ALT provides dual trace operation with sweeps alternating between Ch 1 and Ch 2. In CHOP, the Ch 1 and Ch 2 signals are electronically switched at about a 100 KHz rate to provide dual trace. In the ADD position the Ch 1 signal is added to the Ch 2 signal. Vertical position for this mode is provided by the Ch 1 vertical position control. The CH 2 position selects Ch 2 only.
f) TRACE ∠	Screwdriver adjustment through the front panel which controls the horizontal angle of the trace relative to the graticule.
g) ASTIGMATISM	Screwdriver adjustment through the front panel for control of trace astigmatism.
h) POWER INDICATOR	Green LED indicates power on.

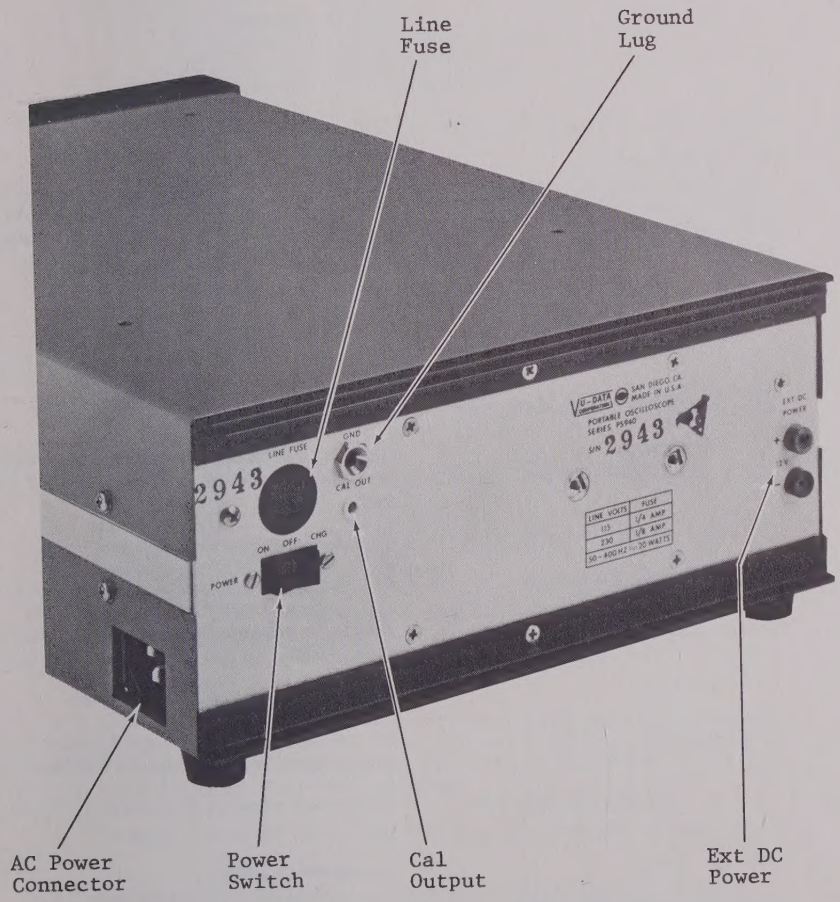

Figure 3-2. Rear Panel View of Series PS940

3-7. CRT Controls

a)	INTENSITY	Controls trace intensity.
b)	FOCUS	Controls trace focus.

3-8. PS943 Controls

Model PS943 adds the X-Y mode of operation. The actual positioning and selecting of front panel controls to obtain X-Y operation will be discussed later in paragraph 3-21. During X-Y operation there is no Ch 1 vertical positioning. Only the Ch 2 vertical position control will position the trace vertically on the CRT.

3-9. REAR PANEL CONTROL FUNCTIONS AND CONNECTIONS

a)	POWER (ON/OFF/CHG)	Three position rocker power switch turns scope on for normal operation or charges the external battery pack.
b)	AC POWER CONNECTOR	Three terminal power cord connector.
c)	115/230V SWITCH	Slide switch selects the proper taps on the power transformer to match the AC line voltage. The switch is located above the fuse and is hidden by the top cover.
d)	FUSE	Power line fuse for instrument protection.
e)	CAL	Pin jack, which provides a one volt P-P square pulse at about 1 KHz for calibrating input probes.
f)	DC POWER CONNECTOR	Two terminal connector for external battery power input.
g)	GND	Provides chassis ground.

3-10. FIRST TIME OPERATION

When operating the Series PS940 for the first time, the following procedures will help you to become familiar with the operating controls and at the same time serves as a useful self test for proper operation.

a. Connect the power cord, which is supplied with the unit, to the rear panel power connector and check that the line voltage switch is set for the line voltage that you will use.

NOTE

If the line voltage switch is changed, be sure that the proper amperage line fuse is installed; 1/4 amp for 115V, 1/8 amp for 230V.

b. Plug the power cord into the AC outlet and turn the power switch on the rear panel to ON. Allow one to two minutes for warm up time.

c. Set the front panel controls as follows:

Vert Input Coupling	Ch 1-DC, Ch 2-DC
Vert Sensitivity (VOLTS/DIV)	Ch 1-.5/div, Ch 2-.5V/div
Vert Vernier	Ch 1-CAL (CW), Ch 2-CAL (CW)
Vert Position	Ch 1 Midrange, Ch 2 Midrange
Trigger Select	INT 1+2
Ch 2 Polarity	NORMAL
Trigger Source	INT
Slope	+
Level	0
Trigger Mode	AUTO
Sweep Rate (TIME/DIV)	1 mS
Sweep Vernier	CW pulled out
Horiz Position	Midrange
Display Mode	CH 1
Intensity	CW
Focus	Midrange

d. Connect a X1 input probe to Ch 1 Vert Input BNC and probe the CAL output jack on the rear panel. You should observe a square pulse two divisions in amplitude, at a frequency of about 1 KHz. Reduce the intensity and adjust the focus for a suitable display.

e. Rotate the Ch 1 vert position control so that the square pulse is symmetrical about the y-axis centerline. Set the Ch 1 AC/DC/GND switch to AC and note the downward shift of the square pulse due to the input now being AC coupled. Switch from AC to GND and note that the square pulse is replaced by a line. Return the switch to DC.

f. Rotate the Ch 1 vertical vernier CCW and note that the square pulse decreases in amplitude.

g. Switch the display mode switch from CH 1 to CH 2 and connect the input cable to Ch 2. You will observe the same display as previously noted. Operate the Ch 2 vertical controls as just performed for Ch 1.

h. Connect another signal input cable from Ch 1 input BNC to the CAL output signal. Switch the display mode switch to ALT and observe a dual trace display.

i. Switch to INT CH 1 and note that the Ch 2 trace inverts as the Ch 2 Polarity (NORMAL/INVERT) switch is operated. Finding out which trace belongs to Ch 2 is easily accomplished by operating the Ch 2 vert position control or switching the Ch 2 AC/DC/GND switch to ground.

NOTE

With the present control setup, the scope will free run if the Ch 1 AC/DC/GND switch is set to GND. This is because the trigger signal is being derived from Ch 1 only and grounding out the Ch 1 signal removes the trigger signal.

j. Switch back to INT 1+2 triggering and note the display as the two traces are positioned vertically apart. When the waveforms do not overlap, the normal triggering will be disturbed due to the AC coupling capacitor used in the AUTO trigger mode. This is normal and may be modified by switching to DC trigger coupling or to LF REJ for high frequency signals. With the trigger selected from INT CH 1 or EXT, there is no problem in separating the traces, since there is no alternating charge disturbance of the triggering signal on the coupling capacitor.

k. Return to AUTO mode. Operate the SLOPE switch from plus to minus and note the square pulse polarity change at the start of the sweep.

l. Switch from AUTO to AC on the trigger mode switch and operate the level control. The trace will disappear when the level setting is greater than the signal amplitude.

m. Operate the sweep controls changing the horizontal positioning, sweep rate (TIME/DIV) switch and vernier. Pull the sweep vernier out and note the increased sweep rate.

n. Switch to CHOP mode and note display. By switching each vertical input coupling switch to GND, trigger mode to AUTO and adjustment of the sweep rate, the chopping action on the trace may be observed. Positioning the two channel vertical controls apart will display a square pulse on the CRT. This shows how each input is sampled as the trace moves across the screen.

o. Switch to the ADD mode and return the vertical coupling switches to DC. Position the trace, using the Ch 1 vertical position control. Operate the Ch 2 Polarity switch and note the algebraic addition or subtraction of the signals.

p. Switch display mode switch to CH 2 and note loss of Ch 1 signal influence. Operate the Ch 2 vertical sensitivity (VOLTS/DIV) switch noting the amplitude change. Switch to INT CH 1.

q. Remove the signal from Ch 1 vertical input and note that the sweep free runs. Switch from INT CH 1 to INT 1+2 and the display should become stable.

r. With a small screwdriver, adjust the astigmatism control for the sharpest display.

s. Switch the Ch 2 input coupling switch to GND. Adjust the trace angle control so that the trace is parallel with the graticule centerline.

3-11. GENERAL OPERATION

3-12. Input Signal Probes

When 10X probes are used with the vertical inputs, they must be compensated for the time constant associated with each input channel. The CAL output may be used to provide the 1 KHz square pulse signal. In using other square pulse sources, it is important not to exceed a frequency of about 5 KHz or the amplitude of the trace will change, making proper probe compensation difficult. The proper waveform is shown in Figure 3-3.

3-13. Channel 1 or Channel 2 Operation

CHANNEL 1 or CHANNEL 2 may be operated as two separate vertical amplifiers by selecting the desired channel using the display mode switch. With the trigger controls set to INT and INT 1+2, the trigger signal will be synchronized to the channel selected by the display mode switch. If INT CH 1 is selected, the trigger signal will come from Ch 1 only and may be used to synchronize the Ch 2 signal frequency to that of the Ch 1 signal frequency by observing a zero beat of Ch 2. It should be noted that in this mode, if the Ch 1 input coupling switch is placed to GND, there will be no trigger signal. When changing the display mode switch, it is advisable to recheck the settings of the trigger source, slope, mode, and level controls to make sure the display is triggered properly.

Each channel has a separate vertical sensitivity selector (VOLTS/DIV) switch with its associated vernier gain control. This switch is accurate when the vernier gain control is in the detented (CW) position. This gain control has a minimum of 2.5 to 1 change so that VOLTS/DIV ranges of 10mV/Div to above 50V/Div can be set.

CAUTION

For accurate, calibrated vertical measurements, the vernier gain control (red knob) must be in the CAL position (CW).

The input coupling switch for each vertical input channel is used to block DC when it is placed in the AC position. The low frequency corner is about 2 Hz with a direct input and approximately 0.2 Hz when using a 10X probe.

CAUTION

Do not exceed 400 volts DC + peak AC when this switch is in the AC position.

The GND position of the input coupling switch is useful when positioning the trace to a zero volt or other reference level for measuring DC levels.

3-14. Alternate Trace Operation

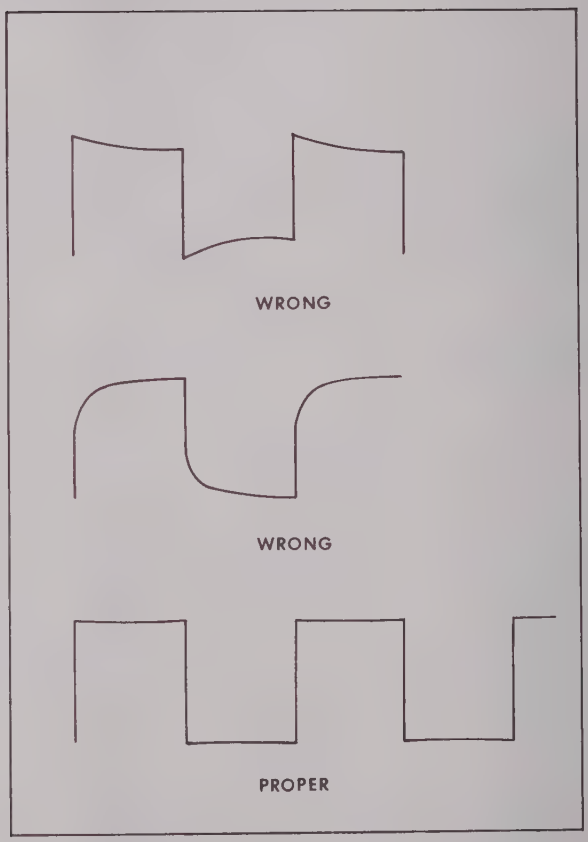

Figure 3-3. Compensated Waveform

Dual trace operation is selected by placing the display mode switch to ALT. In this position, the trace alternates full sweeps between Ch 1 and Ch 2. Each trace may be vertically positioned by the Ch 1 and Ch 2 position controls, however horizontal movement of both traces is controlled together by the horizontal position control.

With the trigger controls placed in AUTO, INT and INT 1+2, the sweeps will be properly triggered, provided the signals overlap each other. When the waveforms do not overlap, the normal trigger ing will be disturbed due to the AC coupling capacitor used in the AUTO trigger mode. This is normal, and may be modified by switching to DC coupling, or to LF REJ for high frequency signals. In LF REJ, the coupling capacitor is much smaller, reducing its effect. Switching to INT CH 1 will also remove the sweep jitter, because the trigger signal is only taken from the CH 1 vertical amplifier before the electronic chopper. This trigger mode is useful for determining the phase relationship between the CH 1 and CH 2 signals. In INT 1+2, the phase relationship of the two traces is not determined since the trigger signal is derived alternately from each vertical channel so that the start of one sweep may not be time related to the start of the next sweep.

3-15. Chop Operation

In the CHOP display mode, an electronic chopper operating at a frequency of about 100 KHz alternately connects the Ch 1 and Ch 2 vertical amplifiers to the vertical output amplifier. It is useful for dual trace display of low frequency signals. Each channel is sampled for about 10 microsecond intervals alternately as the trace sweeps horizontally across the CRT face. For stable triggering, INT CH 1 should be selected. INT 1+2 contains components of the chopped waveform and will result in trace jitter.

3-16. Add Operation

The ADD display mode algebraically adds the Ch 1 waveform to the Ch 2 waveform. To subtract Ch 2 from Ch 1, operate the Ch 2 polarity switch. Use Ch 1 vertical position control to move the trace vertically, since the Ch 2 vertical position control is inoperative in this mode. Triggering may use either EXT, INT CH 1 or INT 1+2 sources. In INT 1+2 the trigger signal is the algebraic sum or difference composite of the two vertical input signals and is useful in special triggering situations; for instance, where it is desired to trigger on a noise pulse which is present after addition or subtraction of the two input waveforms.

When switching to the ADD display mode, the trace at times may be driven off screen due to the addition of DC Components in the waveform. If the trace is not visible, use the Ch 1 vertical position control to bring the trace on screen and the vertical sensitivity selector switches to reduce the amplitude.

3-17. Triggering

The Series PS940 may be triggered from an external or an internal source. The internal source has two modes: (1) INT 1+2 signal is the composite of the two vertical input signals taken after the electronic chopper. (2) INT CH 1 signal is from Ch 1 vertical amplifier only and removed before the electronic chopper. For CH 1 or CH 2 mode, either internal trigger source may be used. In ALT display mode, either source may be used; however, INT CH 1 will give a valid phase relationship between the two traces. In CHOP display mode, use INT CH 1 for jitter-free triggering. Either INT 1+2 or INT CH 1 may be used in the ADD display mode.

The SLOPE switch selects either the plus or minus slope of the waveform at which the sweep starts, and the LEVEL control determines at what point on that slope the trigger occurs. The LEVEL control is disabled when in the AUTO or free run trigger condition. In AUTO, a bright baseline is provided for reference when there is no input signal for triggering. AUTO is AC coupled and requires increasing trigger signal amplitude below about 40 Hz. Except for DC coupling, the trigger signal AC coupling is as follows: AC amplitude requirements increase below 40 Hz, LF REJ amplitude requirements increase below 50 KHz, HF REJ amplitude requirements increase above 50 KHz.

3-18. Sweep Control

The time per division of the horizontal sweep is controlled by a 12 position rotary switch, a push-pull magnifier, and a rotary vernier pot for uncalibrated sweeps. In the CAL (CW) position of the vernier, time may be read directly from the graticule by multiplying the number of horizontal divisions of interest by the selected TIME/DIV factor. For example, if one cycle of a waveform takes 10 horizontal division and the TIME/DIV is set to 1 usec with vernier in CAL, the time per cycle would be 10 usec and the frequency is 100 KHz. $F = \frac{1}{t}$.

3-19. CRT Control

The trace brightness is controlled by the INTENSITY knob. At high intensities the FOCUS knob may need readjusting. The sharpest picture will be obtained using normal intensity and adjusting both the FOCUS and ASTIGMATISM controls. ASTIGMATISM is screwdriver adjusted through the front panel. Use a sine wave when setting the FOCUS and ASTIGMATISM controls. A screwdriver adjustment is also provided to control the angle that the trace makes relative to the graticule. To adjust the TRACE ANGLE, place the trigger mode in AUTO, Sweep rate to about 1 msec and ground both vertical inputs. Adjust the TRACE ANGLE control such that the trace is parallel with the horizontal centerline in the graticule.

3-20. Sweep Magnifier Control

To operate the X5 sweep magnifier, pull the front panel horizontal position knob out. This expands the sweep by a factor of five so that various waveforms on the trace may be examined in more detail by rotating the horizontal position control to locate the desired waveform. Pushing in the horizontal position knob returns the sweep to the unmagnified (X1) rate.

3-21. X-Y Operation (Model PS943 Only)

To operate the Model PS943 in the X-Y mode perform the following steps. Note that all X-Y positions and references are in green on front panels.

a. Connect the horizontal (X) signal to the Ch 1 vertical input BNC connector. Connect the vertical (Y) signal to the Ch 2 vertical input BNC connector.

b. Switch the sweep rate (TIME/DIV) switch fully counterclockwise to one of the last two positions. Either of these last two positions conditions the horizontal board for X-Y operation.

c. Switch the trigger mode switch to the AUTO (X-Y) position.

d. Switch the INT 1+2/CH 1/X-Y switch to the bottom X-Y position. Note that the CH 1 position of the INT 1+2/CH 1/X-Y switch is the same as the INT CH 1 position of INT 1+2/ INT CH 1 used on the Model PS941.

e. Switch the input coupling switches for Ch 1 and Ch 2 to the coupling desired and set the vertical sensitivity (VOLTS/DIV) switches to the desired gain.

f. The scope will now display the X-Y relationship of the input signals. Vertical position is controlled by the Ch 2 vertical position control. The Ch 1 vertical position control will have no effect. Horizontal position is controlled by the horizontal position knob as it is in normal operation. The Y signal may be inverted by the Ch 2 polarity switch.

g. To return the oscilloscope to normal operation, switch the sweep rate selector switch (TIME/DIV) to the proper sweep range, switch the INT 1+2/CH 1/X-Y switch to either INT 1+2 or CH 1. The trigger mode switch may be left in AUTO if desired.